

knowledge and research

## **ROSEBUD AND REDLAND MONITORING WELL INSTALLATION REPORT**

**Alberta Environment**

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## **Rosebud and Redland Monitoring Well Installation Report**

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## 1 INTRODUCTION

The Alberta Environment (AENV) Groundwater Observation Well Network (GOWN) is a network of groundwater wells that monitor groundwater levels in aquifers across Alberta. Within the network some wells are also monitored for a variety of groundwater quality parameters. The network, starting with three wells in 1957, has grown to over 200 wells for better provincial coverage. Regional AENV staff maintain the wells, download data, take manual readings and archive the data into AENV's GOWN database. The AENV Groundwater Information Centre checks the data and maintains the GOWN database.

The Alberta Research Council (ARC) was contracted by AENV to supervise the drilling and installation of three new wells for the GOWN network. This report details the site selection, drilling and well installation data for these monitoring wells.

## 2 MONITORING WELL LOCATIONS

Monitoring well locations were determined by several regional and local factors including:

- Expand the GOWN network into areas that were not covered;
- Monitoring wells at one site were to be in a nest (at different completion depths) to be representative of hydrogeologic conditions at the local (shallow well) and intermediate (deeper well) scales;
- Monitoring well at the second site was to be representative of hydrogeological conditions at the local scale;
- Monitoring wells were to be located in order to minimize impact from nearby pumping wells (domestic or industrial water supply wells);
- Monitoring well sites needed to be accessible to the drilling rig and the AENV sampling trailer at all times of the year; and
- Wells were to be located in the valley to minimize drilling footage.

Two monitoring wells (nest) were installed in the town of Rosebud, Alberta, Wheatland County, in the SW-18-27-21-W4M (Figure 1) on County owned land. The deeper well (Rosebud #1) was located at N 51.18095°, W 112.56919° at a surface elevation of 793 m. The shallower well (Rosebud #2) was located at N 51.18092°, W 112.56922° at a surface elevation of 793 m. The wells were completed in the Horseshoe Canyon Formation of the Late Cretaceous Edmonton Group (Borneuf, 1972; Hydrogeological Consultants Ltd., 2003). A site survey plan is presented in Figure 2.

One monitoring well was installed in the town of Redland, Alberta, Wheatland County, in 9-10-27-22-W4M (Figure 1). The well (Redland #1) was located at N 51.292437°, W 113.005688° at a surface elevation of 800.6 m. The wells were completed in the Horseshoe Canyon Formation of the Late Cretaceous Edmonton Group (Borneuf, 1972; Hydrogeological Consultants Ltd., 2003). A site survey plan is presented in Figure 3.

### 3 MONITORING WELL INSTALLATIONS

The monitoring wells were installed by Gerritsen Drilling Limited of Rockyford Alberta using an Ingersoll Rand TH60 drilling rig (Figure 4). The drilling fluids used included bentonite mud and air in the overburden, and foam and air in the bedrock. Specific details of the drilling operation and the completion details for each well are presented below.

#### 3.1 Rosebud Well #1

Drilling of Rosebud Monitoring Well #1 commenced on March 8, 2007. A test hole was advanced to 18.9 m (62') with a 152 mm (6") tricone drill bit using air to remove cuttings. Cuttings were continuously monitored and logged. Loose sand from the upper section of the hole was noted falling into the hole. The hole was reamed with a 200 mm (7 7/8") bit and a temporary 152 mm (6") plastic well casing was set. The hole was then advanced to the final depth of 141.4 m (464') using a 130 mm (5 1/8") bit. Cuttings were lifted by air. Cuttings were continuously monitored and logged. A detailed lithological description and well completion details are presented Appendix A.

The temporary plastic casing was pulled and bentonite chips were smeared around the borehole (using the bit and stabilizer) to control the loose sand at 14 to 16 feet. The bentonite chips were unsuccessful at controlling the sands so the hole was reamed with a 219 mm (8 5/8") bit and 8.23 m (27') of 219 mm (8 5/8") steel conductor pipe was inserted to control the sand. The hole was then reamed with a 200 mm (7 7/8") bit to a depth of 137.77 m (452') using air and foam to lift the cuttings. A downhole camera revealed that sand continued to wash down the hole from behind the conductor pipe. An additional 2.59 m (8.5') of 219 mm (8 5/8") steel conductor pipe was welded on and pushed into the ground. This was successful at controlling the sand.

A 141 mm (5.56") steel casing with threaded joints was grouted into the ground by pushing bentonite grout down the centre of the casing and getting grout returns up the annulus to the surface. The casing was then driven a short distance into the bedrock to make a good grouted and driven seal. A 114 mm (4.5") OD schedule 40 PVC liner with environmental threads and o-rings, along with 12 evenly spaced K-packers were simultaneously lowered and grouted into place (Figure 4) from above the surface to 141.42 m (464'). The lower end of the liner had a 2.74 m (9') section of 20 slot machined screen. Calcium hypochlorite was used on the threaded joints for disinfection. A schematic diagram of the well completion is presented in Appendix A.

Following completion, the well was Gamma Ray logged by ENZeeTech Inc of Calgary, Alberta. A copy of the gamma log is included in Appendix B.

The well had a casing stick-up of 0.64 m and a total depth of 141.12 m. The well was dry in the completed coal zone and methane gas was present. A compression cap with sampling valve and pressure gauge was fitted to the well and a locking mechanism restricts access to the well.

#### 3.2 Rosebud Well #2

Drilling of Rosebud Monitoring Well #2 commenced on March 22, 2007. A test hole was advanced to 18.9 m (62') with a 200 mm (7 7/8") tricone drill bit using bentonite mud to remove cuttings. A temporary 152 mm (6") plastic well casing was set. The hole was then advanced to the final depth of 55.47 m (182') using a 130 mm (5 1/8") bit. Cuttings were lifted with air. Cuttings

were continuously monitored and logged. A detailed lithological description and well completion details are presented Appendix A.

The temporary plastic casing was pulled and the hole was then reamed with a 200 mm (7 $\frac{7}{8}$ ") bit to a depth of 53.34 m (175') using bentonite mud to lift the cuttings. A 168 mm (6 $\frac{5}{8}$ ") steel casing with welded joints was grouted into the ground by pushing bentonite grout down the centre of the casing and getting grout returns up the annulus to the surface. The casing was then driven a short distance into the bedrock to make a good grouted and driven seal. A 125 mm (4.94") OD schedule 40 PVC liner with threaded joints, along with 3 evenly spaced K-packers were simultaneously lowered and grouted into place from above the surface to 55.47 m (182'). The lower end of the liner had a 2.74 m (9') section of 20 slot machined screen. Calcium hypochlorite was used on the threaded joints for disinfection. A schematic diagram of the well completion is presented in Appendix A. The well was developed with air until the water produced was clear. The apparent well yield was approximately 0.5 Imperial gallons per minute (IGPM).

Following completion, the well was Gamma Ray logged by ENZeeTech Inc of Calgary, Alberta. A copy of the gamma log is included in Appendix B.

The well had a casing stick-up of 0.59 m and a total depth of 55.34 m. The apparent static water level in the well was 13.11 m below ground surface. The well was fitted with a locking cap. The well was shock chlorinated at the completion of the project.

### 3.3 Redland Well

Drilling of Redland Monitoring Well #1 commenced on March 26, 2007. A test hole was advanced to 22.1 m (72.5') with a 200 mm (7 $\frac{7}{8}$ ") tricone drill bit using bentonite mud to remove cuttings. A temporary 152 mm (6") plastic well casing was set. The hole was then advanced to the final depth of 51.51 m (169') using a 130 mm (5 $\frac{1}{8}$ ") bit. Cuttings were lifted with air. Cuttings were continuously monitored and logged. A detailed lithological description and well completion details are presented Appendix A.

The temporary plastic casing was pulled and the hole was then reamed with a 200 mm (7 $\frac{7}{8}$ ") bit to a depth of 50.29 m (165') using bentonite mud to lift the cuttings. A 168 mm (6 $\frac{5}{8}$ ") steel casing with welded joints was grouted into the ground by pushing bentonite grout down the centre of the casing and getting grout returns up the annulus to the surface. The casing was then driven a short distance into the bedrock to make a good grouted and driven seal. A 125 mm (4.94") OD schedule 40 PVC liner with threaded joints, along with 4 evenly spaced K-packers was simultaneously lowered and grouted into place from above the surface to 51.51 m (169'). The lower end of the liner had a 2.74 m (9') section of 20 slot machined screen. Calcium hypochlorite was used on the threaded joints for disinfection. A schematic diagram of the well completion is presented in Appendix A. The well was developed with air until the water produced was clear. The apparent well yield was approximately 1 IGPM.

Following completion, the well was Gamma Ray logged by ENZeeTech Inc of Calgary, Alberta. A copy of the gamma log is included in Appendix B.

The well had a casing stick-up of 0.60 m and a total depth of 51.44 m. The apparent static water level in the well was 4.76 m below ground surface. The well was fitted with a locking cap. The well was shock chlorinated at the completion of the project.

#### 4 CONCLUSIONS AND RECOMMENDATIONS

The following key points are summarized for the drilling programs in Rosebud and Redland.

- Exploration drilling in Rosebud encountered an apparently saturated silty sand and sand from about 2 to 5 m.
- Exploration drilling in Rosebud encountered several water bearing coal zones above 55 m. The main water bearing coal zone was encountered from 54.25 to 55.17 m. The well completed in this zone (Rosebud Well #2) yielding approximately 0.5 IGPM. This is consistent with the depth and yield of most local water wells (Alberta Environment Provincial Water Well Data Base, 2004).
- In Rosebud no water was encountered from below about 55 m to the maximum depth drilled (about 141 m). No water was encountered in the screened interval of Rosebud Well #1 but methane gas was encountered.
- Exploration drilling in Redland encountered a fine gravel from about 6.4 to 7.3 m.
- Exploration drilling in Redland encountered a minor water bearing sandstone at approximately 48 m. The main water bearing coal zone was encountered from 50.59 to 51.21 m. The well completed in this zone (Redland Well #1) yielded approximately 1 IGPM. This is consistent with the depth and yield of most local water wells (Alberta Environment Provincial Water Well Data Base 2004).

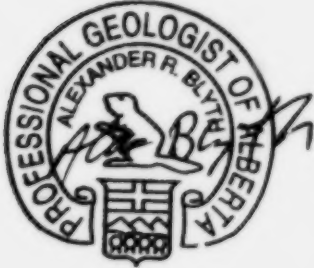
Based on the drilling and testing program at Rosebud and Redland, the following recommendations are made.

- These monitoring wells should be equipped with an automatic water level monitoring device (such as an In-Situ MiniTROLL) to monitor impacts of stresses on the regional aquifer system by water withdrawals or drought.
- Prior to geochemical sampling of Rosebud Well #2 and Redland Well #1, the wells should undergo a pumping test to determine aquifer hydraulic properties. This will also remove residual chlorine resulting from the shock chlorination of the wells.
- Rosebud Well #1 gas should be sampled and analysed for composition (GC analysis) and carbon and hydrogen isotopes.
- The Rosebud Well #1 will need to be licensed by the Alberta Energy and Utilities Board (AEUB). This process has been initiated by AENV.

This work was carried out in accordance with accepted hydrogeological and groundwater engineering practices.

Respectfully submitted,

Alberta Research Council



Alexander Blyth, Ph.D., P.Geol.  
Research Hydrogeologist

## 5 REFERENCES

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Alberta Environment Provincial Water Well Data Base (2004).

Borneuf, D., 1972. Hydrology of the Drumheller Area, Alberta. Alberta Research Council Report 72-1.

Hydrogeological Consultants Ltd., 2003. Wheatland County – Part of the South Saskatchewan Basin, Tp 021 to 028, R 17 to 26, W4M. PFRA Regional Groundwater Assessment Report.

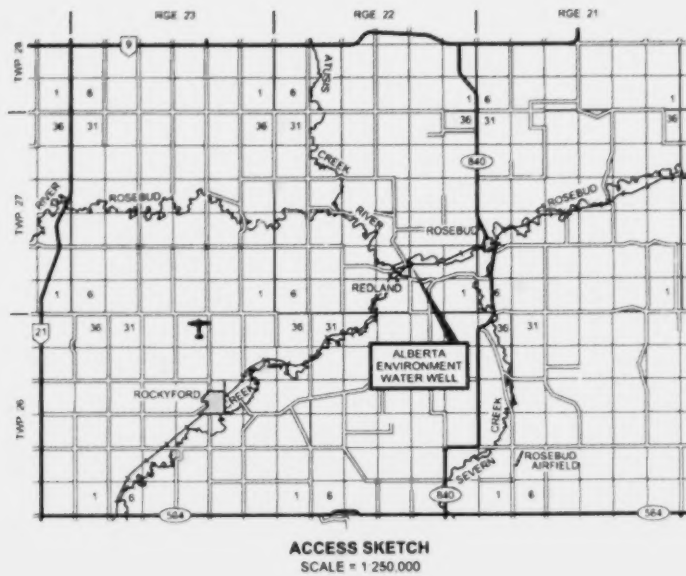


Figure 1. General site location map.

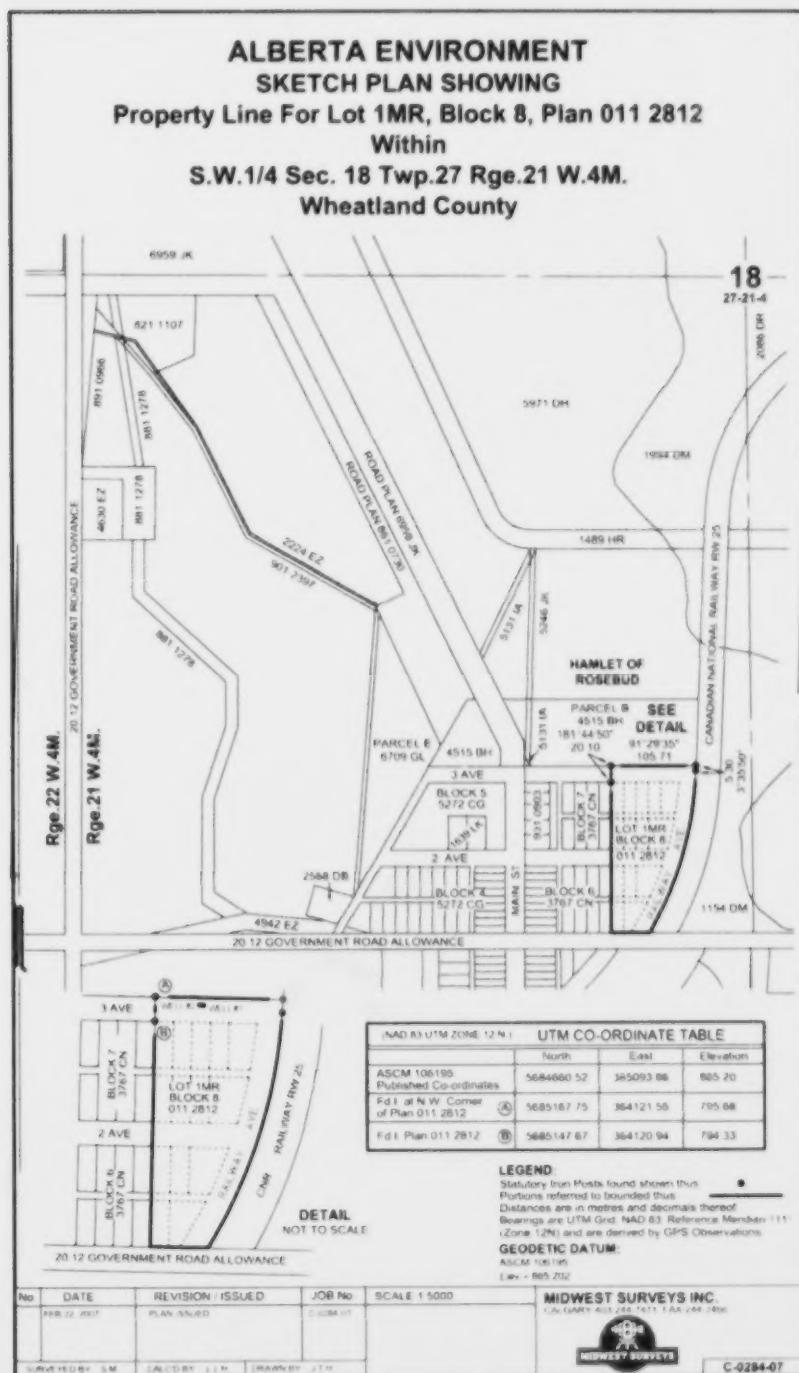


Figure 2. Detailed map of Rosebud area.





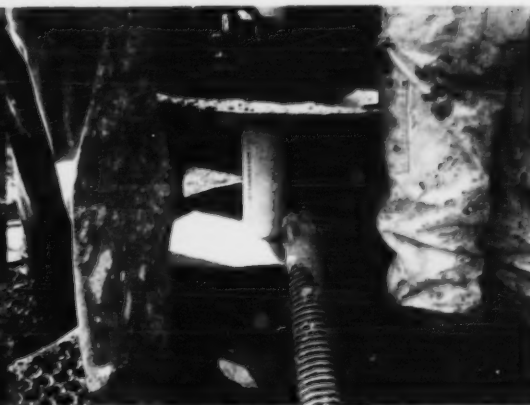
Ingersoll-Rand TH60 Drilling Rig



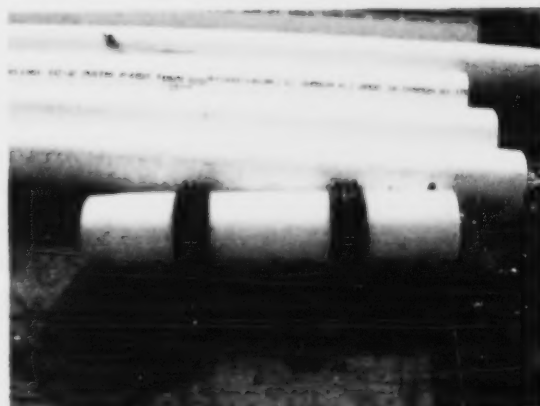
Tricone bit and Stabilizer



Wildon M15 Diaphragm Grout Pump

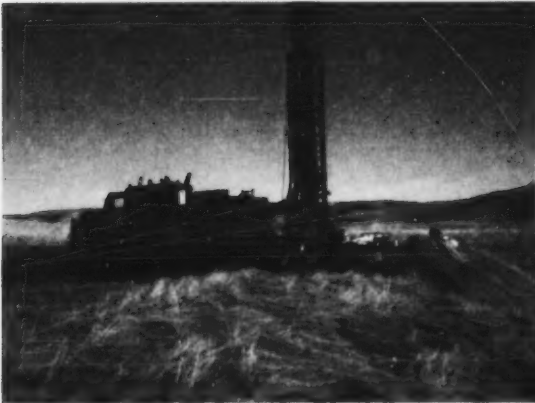


Installing and Grouting Liner



K-Packer on Casing Liner

Figure 4. Photographs



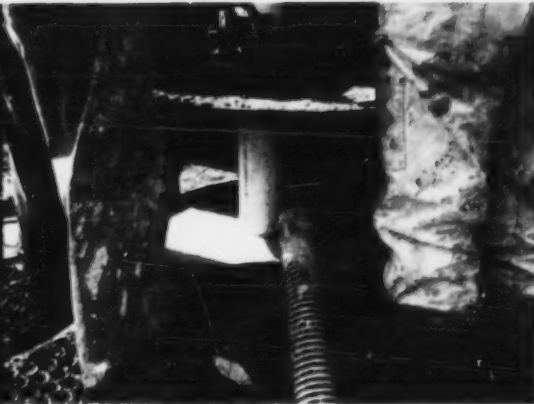
Ingersoll-Rand TH60 Drilling Rig



Tricone bit and Stabilizer



Wildon M15 Diaphragm Grout Pump



Installing and Grouting Liner



K-Packer on Casing Liner

Figure 4. Photographs

## Appendix A

### Lithological Description and Well Completion Details



Rosebud Well #1  
SW-16-27-21 W4  
N 51 18095", W 112 5619, 793 m

Depth from Ground (feet)	Lithology Description
0 2	Clayey Silt, med. brown
2 3	Silty Clay, med. brown
3 5	Clayey Silt, med. brown
5 6.5	Sandy Silt, lt. brown
6.5 14	Silty Sand, lt. brown, occasional pebble
14 16	Sand, medium, occasional pebble, poorly sorted, subrounded
16 32	Clayey Silt, sand from above mixed with returns
32 62	Silty Clay, med. grey
62 66	Siltstone, med. grey, highly weathered, soft
66 80	Siltstone, med. grey
80 82	Sandstone, lt. Grey, fine grained
82 97	Siltstone, med. grey
97 99	Sandstone, lt. grey, soft, Water ~0.5 IGPM
99 112	Shale, black, silty in places
112 117	Sandstone, lt. grey, soft, fine grained
117 120	Siltstone, med. grey
120 124	Sandstone, lt. grey, hard, fine grained
124 132	Shale, black, occasional lt brown surfaces
132 133	COAL (Weaver coal), Water ~1 IGPM
133 145	Shale, black
145 147	Sandstone, lt. Grey, fine grained
147 148	COAL (Weaver coal), Water minor
148 155	Shale, med. brown, silty
155 156	Sandstone, lt. grey, hard, fine grained
156 158.5	COAL (Weaver coal), Water minor
158.5 165	Siltstone, med. grey
165 167	Sandstone, lt. grey, fine grained
167 170	Shale, black
170 178	Sandstone, lt. grey, hard, fine grained
178 181	COAL (Weaver coal), Water ~1.5 IGPM
181 190	Shale, black
190 193	Sandstone, lt. grey, fine grained
193 209	Shale, black, occasional lt brown, hard siliceous layers
209 216	Sandstone, lt. grey, fine grained
216 235	Shale, black, Bentonitic clay layer at 219'
235 236	Sandstone, lt. grey, very hard, siliceous, fine grained
236 258	Shale, black
258 263	Sandstone, lt. grey, hard, fine grained
263 310	Siltstone, med. grey, Minor coal at 278'
310 311	COAL (Garden Plains)
311 314	Shale, black
314 317	Sandstone, lt. grey, fine grained
317 326	Shale, black, minor siliceous layer, minor coal at 326'
326 329	Sandstone, lt. grey, hard, fine grained
329 330	Shale, black
330 333	Sandstone, grey, hard, fine grained
333 334	Shale, black
334 335	Sandstone, grey, hard, fine grained
335 337	Siltstone, med. grey
337 339	Sandstone, lt. grey, fine grained, Siliceous layer at 338'
339 342	Shale, black
342 343	COAL (Garden Plains)
343 354	Shale, black, Silty at 351'
354 357	Sandstone, lt. grey, hard, fine grained
357 358	COAL (Garden Plains)
358 359	Sandstone, lt. grey, fine grained
359 368	Siltstone, med. grey
368 370	Sandstone, lt. grey, fine grained, silty
370 372	Siltstone, med. grey
372 373	Sandstone, lt. grey, fine grained
373 374.5	Siltstone, med. grey, Siliceous layer at 374'
374.5 400	Shale, black, Siliceous layer at 395'
400 406	Sandstone, lt. grey, hard, fine grained
406 407	Siltstone, med. grey
407 409	Sandstone, lt. grey, hard, fine grained
409 425	Siltstone, med. grey, Silty from 424-425"
425 432	Shale, black
432 434	COAL (Garden Plains coal)
434 437	Siltstone, med. grey
437 443	Sandstone, lt. grey, fine grained, Siliceous layer at 439' and 442'
443 454	Siltstone, med. grey
454 460	COAL (Garden Plains)
460 461	Siltstone, med. grey
461 463	COAL (Garden Plains), shaley lenses
463 464	Siltstone, med. grey

End of hole

#### Completion Details

Borehole diameter 7 7/8" from surface to 450' (137.16 m)

Borehole diameter 5 15/16" from 450-464' (137.16 to 141.42 m)

Steel conductor pipe 8 5/8" from surface to 35 5' (10.82 m)

Steel Casing diameter 5 9/16" (ID), threaded joints, from -2.1 - 452' (-0.64m to 137.77 m)

Liner diameter 4 5" (OD), environmental threads with o-rings, from -2.1 to 464' (-0.64 to 141.42 m)

Screened section of liner, 20 slot machined

Bentonite grout from surface to 452' (137.77 m) outside steel casing

Bentonite grout from surface to 452' (137.77 m) between steel casing and liner

12 evenly spaced K-Packers

#### Completed Well Measurements

Depth of well 464.97' (141.76 m) to Top of Casing

Casing Stick up 2.10' (0.64 m)

Total depth of well 463' (141.12 m) below ground surface

Static Water Level - no water, 54 PSI pressure

Rosebud Drilling		Rosebud/Redland		BOREHOLE: Rosebud Well 1	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.181 West: 112.569		ELEVATION: 2601.706 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input type="checkbox"/> Bentonite <input type="checkbox"/> Grout <input type="checkbox"/> Backfill <input type="checkbox"/> Sand <input type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input type="checkbox"/> Shelby Tube <input type="checkbox"/> No Recovery <input type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input type="checkbox"/> Core <input type="checkbox"/> Grab Sample					
<div style="display: flex; justify-content: space-between;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Depth (ft)</div> <div> <h2 style="text-align: center;">LITHOLOGIC DESCRIPTION</h2> </div> </div>		<h2 style="margin: 0;">WELL INSTALLATION</h2> <p style="font-size: small; margin: 0;">Casing diam. = 0.464 ft Borehole diam. = 0.654 ft</p>		<div style="display: flex; justify-content: space-between;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Elevation (ftasl)</div> </div>	
1.0	Clayey Silt			2602.0	
2.0				2603.0	
3.0	Silty Clay			2604.0	
4.0				2605.0	
5.0	Clayey Silt			2606.0	
6.0				2607.0	
7.0	Sandy Silt			2608.0	
8.0				2609.0	
9.0	Silty Sand - Occasional pebble			2610.0	
10.0				2611.0	
11.0				2612.0	
12.0				2613.0	
13.0				2614.0	
14.0				2615.0	
15.0	Sand - Medium, occasional pebble, poorly sorted, subrounded			2616.0	
16.0				2617.0	
17.0				2618.0	
18.0				2619.0	
19.0	Clayey Silt - Sand from above mixed with returns			2620.0	
20.0				2621.0	
21.0				2622.0	
22.0				2623.0	
23.0				2624.0	
24.0				2625.0	
25.0				2626.0	
26.0				2627.0	
27.0				2628.0	
28.0				2629.0	
29.0				2630.0	
30.0				2631.0	
31.0				2632.0	
32.0				2633.0	
33.0	Silty Clay			2634.0	
34.0				2635.0	
35.0				2636.0	
36.0				2637.0	
37.0				2638.0	
38.0				2639.0	
39.0				2640.0	
40.0				2641.0	
41.0				2642.0	
42.0				2643.0	
43.0				2644.0	
44.0				2645.0	
45.0				2646.0	
46.0				2647.0	
47.0				2648.0	
48.0				2649.0	
49.0				2650.0	
50.0				2651.0	
51.0				2652.0	
52.0				2653.0	
53.0				2654.0	
54.0				2655.0	
55.0				2656.0	
56.0				2657.0	
57.0				2658.0	
58.0				2659.0	
59.0				2660.0	
60.0				2661.0	
61.0				2662.0	
62.0				2663.0	
63.0	Siltstone - Highly weathered, soft			2664.0	
64.0				2665.0	
65.0				2666.0	
66.0				2667.0	
67.0	Siltstone			2668.0	
68.0				2669.0	
69.0				2670.0	
70.0				2671.0	
71.0				2672.0	
72.0				2673.0	
73.0				2674.0	
74.0				2675.0	
75.0				2676.0	
76.0				2677.0	
77.0				2678.0	
78.0				2679.0	
79.0				2680.0	
80.0				2681.0	
81.0	Sandstone - Fine grained			2682.0	
82.0				2683.0	
83.0	Siltstone			2684.0	
84.0				2685.0	
				2686.0	
Alberta Research Council		LOGGED BY: Alec Blyth		COMPLETION DEPTH: 464.00 (ft)	
Date printed: 12-Apr-2007		TYPE: Gas Monitoring Well		COMPLETED:	

Rosebud Drilling		Rosebud/Redland		BOREHOLE: Rosebud Well 1	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.181 West: 112.569		ELEVATION: 2601.706 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input type="checkbox"/> Bentonite <input type="checkbox"/> Grout <input type="checkbox"/> Backfill <input type="checkbox"/> Sand <input type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input type="checkbox"/> Shelby Tube <input type="checkbox"/> No Recovery <input type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input type="checkbox"/> Core <input type="checkbox"/> Grab Sample					

D e p t h  (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION		E l e v  (ftasl)
		Casing diam. = 0.464 ft Borehole diam. = 0.654 ft		
86.0				2601.70
87.0				2600.00
88.0				2600.00
89.0				2600.00
90.0				2600.00
91.0				2600.00
92.0				2600.00
93.0				2600.00
94.0				2600.00
95.0				2600.00
96.0				2600.00
97.0				2600.00
98.0	Sandstone - Soft, water ~0.5 IGPM			2600.00
99.0				2600.00
100	Shale - Silty in places			2600.00
101				2600.00
102				2600.00
103				2600.00
104				2600.00
105				2600.00
106				2600.00
107				2600.00
108				2600.00
109				2600.00
110				2600.00
111				2600.00
112				2600.00
113	Sandstone - Soft, fine grained			2600.00
114				2600.00
115				2600.00
116				2600.00
117				2600.00
118	Siltstone			2600.00
119				2600.00
120				2600.00
121	Sandstone - Hard, fine grained			2600.00
122				2600.00
123				2600.00
124				2600.00
125	Shale - Occasional light brown surfaces			2600.00
126				2600.00
127				2600.00
128				2600.00
129				2600.00
130				2600.00
131				2600.00
132				2600.00
133	Coal - WEAVER COAL., water ~1 IGPM			2600.00
134				2600.00
135	Shale			2600.00
136				2600.00
137				2600.00
138				2600.00
139				2600.00
140				2600.00
141				2600.00
142				2600.00
143				2600.00
144				2600.00
145				2600.00
146	Sandstone - Fine grained			2600.00
147				2600.00
148	Coal - WEAVER COAL., water minor			2600.00
149				2600.00
150	Shale - Silty			2600.00
151				2600.00
152				2600.00
153				2600.00
154				2600.00
155				2600.00
156	Sandstone - Hard, fine grained			2600.00
157				2600.00
158				2600.00
159	Coal - WEAVER COAL., water minor			2600.00
160				2600.00
161	Siltstone			2600.00
162				2600.00
163				2600.00
164				2600.00
165				2600.00
166	Sandstone - Fine grained			2600.00
167				2600.00
168	Shale			2600.00
169				2600.00

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 464.00 (ft)
Date printed: 12-Apr-2007	TYPE: Gas Monitoring Well	COMPLETED:

Rosebud Drilling		Rosebud/Redland		BOREHOLE: Rosebud Well 1	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.181 West: 112.569		ELEVATION: 2601.706 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input checked="" type="checkbox"/> Bentonite <input checked="" type="checkbox"/> Grout <input checked="" type="checkbox"/> Backfill <input type="checkbox"/> Sand <input checked="" type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input checked="" type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> No Recovery <input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input checked="" type="checkbox"/> Core <input type="checkbox"/> Grab Sample					
D e p t h  (ft)		<b>LITHOLOGIC DESCRIPTION</b>		<b>WELL INSTALLATION</b> Casing diam. = 0.464 ft Borehole diam. = 0.654 ft (ftasl)	
171	Sandstone - Hard, fine grained				2773
172					2774
173					2775
174					2776
175					2777
176					2778
177					2779
178	Coal - WEAVER COAL, water ~1.5 IGPM				2780
179					2781
180					2782
181	Shale				2783
182					2784
183					2785
184					2786
185					2787
186					2788
187					2789
188					2790
189					2791
190	Sandstone - Fine grained				2792
191					2793
192					2794
193					2795
194	Shale - Occasional light brown, hard				2796
195	siliceous layers				2797
196					2798
197					2799
198					2800
199					2801
200					2802
201					2803
202					2804
203					2805
204					2806
205					2807
206					2808
207					2809
208					2810
209					2811
210	Sandstone - Fine grained				2812
211					2813
212					2814
213					2815
214					2816
215					2817
216					2818
217	Shale - Bentonitic clay layer at 219'				2819
218					2820
219					2821
220					2822
221					2823
222					2824
223					2825
224					2826
225					2827
226					2828
227					2829
228					2830
229					2831
230					2832
231					2833
232					2834
233					2835
234					2836
235					2837
236	Sandstone - Very hard, siliceous, fine				2838
237	grained				2839
238					2840
239					2841
240	Shale				2842
241					2843
242					2844
243					2845
244					2846
245					2847
246					2848
247					2849
248					2850
249					2851
250					2852
251					2853
252					2854
253					2855
254					2856
Alberta Research Council			LOGGED BY: Alec Blyth TYPE: Gas Monitoring Well		COMPLETION DEPTH: 464.00 (ft) COMPLETED:

Date printed: 12-Apr-2007

Rosebud Drilling		Rosebud/Redland		BOREHOLE: Rosebud Well 1	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.181 West: 112.569		ELEVATION: 2601.706 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input type="checkbox"/> Bentonite <input type="checkbox"/> Grout <input type="checkbox"/> Backfill <input type="checkbox"/> Sand <input type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input type="checkbox"/> Shelby Tube <input type="checkbox"/> No Recovery <input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input type="checkbox"/> Core <input type="checkbox"/> Grab Sample					
D e p t h  (ft)	<b>LITHOLOGIC DESCRIPTION</b>		<b>WELL INSTALLATION</b> Casing diam. = 0.464 ft Borehole diam. = 0.654 ft		E l e v  (ftasl)
256	Sandstone - Hard, fine grained				256
257					259
258	Siltstone - Minor coal at 278'				260
259					261
260					262
261					263
262					264
263					265
264					266
265					267
266					268
267					269
268					270
269					271
270					272
271					273
272					274
273					275
274					276
275					277
276					278
277					279
278					280
279					281
280					282
281					283
282					284
283					285
284					286
285					287
286					288
287					289
288					290
289					291
290					292
291					293
292					294
293					295
294					296
295					297
296					298
297					299
298					300
299					301
300					302
301					303
302					304
303					305
304					306
305					307
306					308
307					309
308					310
309					311
310					312
311	Coal - GARDEN PLAINS				313
312	Shale				314
313	Sandstone - Fine grained				315
314	Shale - Minor siliceous layer, minor coal at 326'				316
315					317
316					318
317					319
318					320
319					321
320					322
321					323
322					324
323					325
324					326
325					327
326					328
327					329
328					330
329	Sandstone - Hard, fine grained				331
330	Shale				332
331					333
332	Sandstone - Hard, fine grained				334
333	Shale				335
334					336
335					337
336					338
337					339
338					340
339					341
Siltstone					
Alberta Research Council		LOGGED BY: Alec Blyth		COMPLETION DEPTH: 464.00 (ft)	
Date printed: 12-Apr-2007		TYPE: Gas Monitoring Well		COMPLETED:	

Rosebud Drilling		Rosebud/Redland		BOREHOLE: Rosebud Well 1	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.181 West: 112.569		ELEVATION: 2601.706 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input type="checkbox"/> Bentonite <input type="checkbox"/> Grout <input type="checkbox"/> Backfill <input type="checkbox"/> Sand <input type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input type="checkbox"/> Shelby Tube <input type="checkbox"/> No Recovery <input type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input type="checkbox"/> Core <input type="checkbox"/> Grab Sample					
<div style="display: flex; justify-content: space-between;"> <div> <div style="display: flex; align-items: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Depth (ft)</div> <div style="margin-left: 10px;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">LITHOLOGIC DESCRIPTION</div> </div> </div> </div> <div> <div style="border: 1px solid black; padding: 5px; text-align: center;">WELL INSTALLATION</div> <div style="font-size: small;">Casing diam. = 0.464 ft Borehole diam. = 0.654 ft</div> </div> <div style="display: flex; align-items: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Elevation (ftasl)</div> </div> </div>					
341					2942
342					2943
343	Coal - GARDEN PLAINS				2944
344					2945
345	Shale - Sandy at 351'				2946
346					2947
347					2948
348					2949
349					2950
350					2951
351					2952
352					2953
353					2954
354					2955
355	Sandstone - Hard, fine grained				2956
356					2957
357					2958
358	Coal - GARDEN PLAINS				2959
359					2960
360	Sandstone - Fine grained				2961
361					2962
362	Siltstone				2963
363					2964
364					2965
365					2966
366					2967
367					2968
368					2969
369	Sandstone - Fine grained, silty				2970
370					2971
371	Siltstone				2972
372					2973
373	Sandstone - Fine grained				2974
374					2975
375	Siltstone - Siliceous layer at 374'				2976
376					2977
377	Shale - Siliceous layer at 395'				2978
378					2979
379					2980
380					2981
381					2982
382					2983
383					2984
384					2985
385					2986
386					2987
387					2988
388					2989
389					2990
390					2991
391					2992
392					2993
393					2994
394					2995
395					2996
396					2997
397					2998
398					2999
399					3000
400					3001
401	Sandstone - Hard, fine grained				3002
402					3003
403					3004
404					3005
405					3006
406					3007
407	Siltstone				3008
408					3009
409	Sandstone - Hard, fine grained				3010
410					3011
411	Siltstone - Sandy from 424-425'				3012
412					3013
413					3014
414					3015
415					3016
416					3017
417					3018
418					3019
419					3020
420					3021
421					3022
422					3023
423					3024
424					3025
					3026
Alberta Research Council		LOGGED BY: Alec Blyth		COMPLETION DEPTH: 464.00 (ft)	
Date printed: 12-Apr-2007		TYPE: Gas Monitoring Well		COMPLETED:	

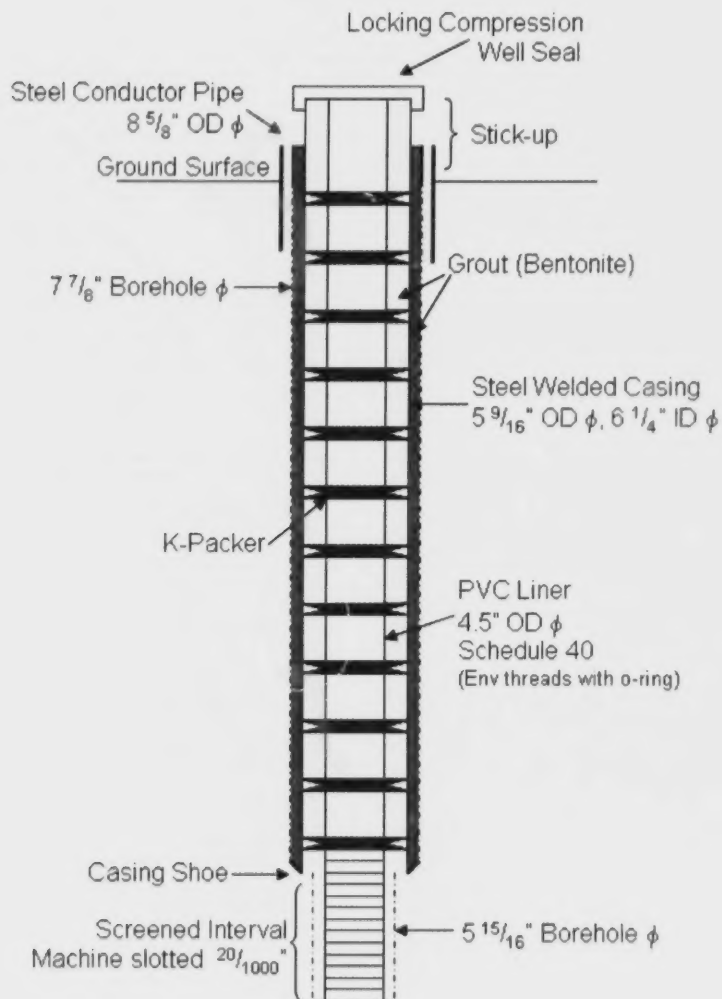
Rosebud Drilling		Rosebud/Redland		BOREHOLE: Rosebud Well 1	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.181 West: 112.569		ELEVATION: 2601.706 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input checked="" type="checkbox"/> Bentonite <input checked="" type="checkbox"/> Grout <input checked="" type="checkbox"/> Backfill <input type="checkbox"/> Sand <input checked="" type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input checked="" type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> No Recovery <input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input checked="" type="checkbox"/> Core <input type="checkbox"/> Grab Sample					

LITHOLOGIC DESCRIPTION		WELL INSTALLATION	
		Casing diam. = 0.404 ft Borehole diam. = 0.654 ft	
426	Shale		426
427			427
428			428
429			429
430			430
431			431
432			432
433			433
434			434
435			435
436	Coal - GARDEN PLAINS		436
437	Siltstone		437
438	Siltstone		438
439	Sandstone - Fine grained, siliceous layer at 439' and 442'		439
440			440
441			441
442	Siltstone		442
443			443
444			444
445	Coal - GARDEN PLAINS		
446		446	
447		447	
448		448	
449		449	
450		450	
451		451	
452		452	
453		453	
454		454	
455	Siltstone		455
456			456
457			457
458			458
459			459
460			460
461			461
462			462
463			463
464			464
465	Coal - GARDEN PLAINS, shaley lenses		465
466	END OF HOLE AT 464.0 ft Other wells in nest: 1 Well status: Active		466
467			467
468			468
469			469
470			470
471			471
472			472
473			473
474			474
475		475	
476			476
477			477
478			478
479			479
480			480
481			481
482			482
483			483
484			484
485			485
486			486
487			487
488			488
489			489
490			490
491			491
492			492
493			493
494			494
495			495
496			496
497			497
498			498
499			499
500			500
501			501
502			502
503			503
504			504
505			505
506			506
507			507
508			508
509			509
			510
			511

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 464.00 (ft)
Date printed: 12 Apr 2007	TYPE: Gas Monitoring Well	COMPLETED:



Schematic Completion Diagram for Rosebud Monitoring Well #1  
(not to scale)

Rosebud Well #2  
 SW-18-27-21 W4  
 N 51.18092° W 112.56922° 793 m

Depth from Ground (feet)		Lithology Description
0	2	Clayey Silt, med. brown
2	3	Silty Clay, med. brown
3	5	Clayey Silt, med. brown
5	6.5	Sandy Silt, lt. brown
6.5	14	Silty Sand, lt. brown, occasional pebble
14	15	Sand, medium to coarse grained, poorly sorted, subrounded
15	17	Silty Sand, lt. brown, some clay
17	20	Clayey Silt, lt. grey, some sand
20	26	Silty Clay, lt. grey, with occasional pebble
26	28	Clayey Silt, lt. Grey
28	51	Silty Clay, lt. grey, with occasional pebble
51	61	Silty Clay, bluish grey
61	67	Siltstone, med. brown, highly weathered, soft
67	83	Siltstone, med. grey
83	86	Sandstone, lt. grey, fine grained
86	90	Siltstone, med. grey
90	96	Shale, black
96	99	Siltstone, med. grey
99	99.5	COAL (Carbon Thompson), shaley, Water ~ 0.25 IGPM
99.5	103	Shale, black
103	104	Siltstone, med. grey
104	112	Shale, black
112	118	Sandstone, lt. grey, fine grained
118	120	Siltstone, med. grey
120	127	Sandstone, lt. grey, fine grained
127	129	Siltstone, med. grey
129	130	Shale, black
130	131.0	Siltstone, med. grey
131.0	132.5	COAL (Weaver), Water ~ 0.5 IGPM
132.5	142	Shale, black
142	145	Sandstone, lt. grey, fine grained
145	145.5	Shale, brown
145.5	146	COAL (Weaver), Water minor
146	146.5	Shale, bentonitic
146.5	153	Shale, black
153	161	Sandstone, lt. grey, fine grained
161	172	Shale, black
172	176	Sandstone, lt. grey, fine grained
176	178	Shale, black
178	181	COAL (Weaver), Water ~ 0.75 IGPM
181	182	Shale, black

End of Hole

#### Completion Details:

Borehole diameter 7 7/8" from surface to 175' (53.34 m)  
 Borehole diameter 5 15/16" from 175-182' (53.34 to 55.47 m)  
 Steel Casing diameter 6 5/8" (OD), 6 1/4" (ID), welded joints, from -1.94' - 175' (-0.59m to 53.34 m)  
 Liner diameter 4 1/4" (OD), 4 5" (ID), threaded, from -1.94' - 182' (-0.59m to 55.47 m)  
 Screened section of liner, 20 slot machined, 173-182' (52.73 to 55.47 m)  
 Bentonite grout from surface to 175' (53.34 m) outside steel casing.  
 Bentonite grout from surface to 173' (52.73 m) between steel casing and liner  
 K-Packers at 60, 120 and 172'  
 Completed Well Measurements  
 Depth of well 183.45' (55.92 m) to Top of Casing  
 Casing Stick up 1.94' (0.59 m)  
 Total depth of well 181.51' (55.34 m) below ground surface  
 Static Water Level 13.11 m (below ground surface)

Rosebud Drilling		Rosebud/Redland		BOREHOLE: Rosebud Well 2	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.181 West: 112.569		ELEVATION: 2601.706 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input checked="" type="checkbox"/> Bentonite <input checked="" type="checkbox"/> Grout <input checked="" type="checkbox"/> Backfill <input type="checkbox"/> Sand <input checked="" type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input checked="" type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> No Recovery <input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input checked="" type="checkbox"/> Core <input type="checkbox"/> Grab Sample					

Depth (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION		Elevation (ftasl)
		Casing diam. = 0.552 ft Borehole diam. = 0.654 ft		
1.0	Clayey Silt - medium brown			2602.0
2.0				2603.0
3.0	Silty Clay - medium brown			2604.0
4.0				2605.0
5.0	Clayey Silt - medium brown			2606.0
6.0				2607.0
7.0	Sandy Silt - light brown			2608.0
8.0				2609.0
9.0	Silty Sand - light brown, occasional pebble			2610.0
10.0				2611.0
11.0				2612.0
12.0				2613.0
13.0				2614.0
14.0				2615.0
15.0	Sand - medium to coarse grained, poorly sorted, subrounded			2616.0
16.0				2617.0
17.0				2618.0
18.0	Silty Sand - light brown, some clay			2619.0
19.0				2620.0
20.0	Clayey Silt - light gray, some sand			2621.0
21.0				2622.0
22.0	Silty Clay - light gray, with occasional pebble			2623.0
23.0				2624.0
24.0				2625.0
25.0				2626.0
26.0				2627.0
27.0	Clayey Silt - light gray			2628.0
28.0				2629.0
29.0	Silty Clay - light gray, with occasional pebble			2630.0
30.0				2631.0
31.0				2632.0
32.0				2633.0
33.0				2634.0
34.0				2635.0
35.0				2636.0
36.0				2637.0
37.0				2638.0
38.0				2639.0
39.0				2640.0
40.0				2641.0
41.0				2642.0
42.0				2643.0
43.0				2644.0
44.0				2645.0
45.0				2646.0
46.0				2647.0
47.0				2648.0
48.0				2649.0
49.0				2650.0
50.0				2651.0
51.0				2652.0
52.0	Silty Clay - blueish gray			2653.0
53.0				2654.0
54.0				2655.0
55.0				2656.0
56.0				2657.0
57.0				2658.0
58.0				2659.0
59.0				2660.0
60.0				2661.0
61.0				2662.0
62.0	Siltstone - medium brown, highly weathered, soft			2663.0
63.0				2664.0
64.0				2665.0
65.0				2666.0
66.0				2667.0
67.0				2668.0
68.0	Siltstone - medium gray			2669.0
69.0				2670.0
70.0				2671.0
71.0				2672.0
72.0				2673.0
73.0				2674.0
74.0				2675.0

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 183.45 (ft)
	TYPE: Groundwater Monitoring Well	COMPLETED:


Date printed: 12 Apr 2007

Rosebud Drilling		Rosebud/Redland		BOREHOLE: Rosebud Well 2	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.181 West: 112.569		ELEVATION: 2601.706 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input checked="" type="checkbox"/> Bentonite <input checked="" type="checkbox"/> Grout <input checked="" type="checkbox"/> Backfill <input type="checkbox"/> Sand <input checked="" type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input checked="" type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> No Recovery <input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input checked="" type="checkbox"/> Core <input type="checkbox"/> Grab Sample					
D e p t h  (ft)	<b>LITHOLOGIC DESCRIPTION</b>			<b>WELL INSTALLATION</b> Casing diam. = 0.552 ft Borehole diam. = 0.654 ft  (ftasl)	
76.0				2677.0	
77.0				2678.0	
78.0				2679.0	
79.0				2680.0	
80.0				2681.0	
81.0				2682.0	
82.0				2683.0	
83.0				2684.0	
84.0	Sandstone - light gray, fine grained			2685.0	
85.0				2686.0	
86.0				2687.0	
87.0	Siltstone - medium gray			2688.0	
88.0				2689.0	
89.0				2690.0	
90.0				2691.0	
91.0	Shale - black			2692.0	
92.0				2693.0	
93.0				2694.0	
94.0				2695.0	
95.0				2696.0	
96.0				2697.0	
97.0	Siltstone - medium gray			2698.0	
98.0				2699.0	
99.0				2700.0	
100	Coal - CARBON THOMPSON, shaley, water			2701	
101	-0.25 IGPM			2702	
102				2703	
103	Shale - black			2704	
104				2705	
105	Siltstone - medium gray			2706	
106				2707	
107	Shale - black			2708	
108				2709	
109				2710	
110				2711	
111				2712	
112				2713	
113	Sandstone - light gray, fine grained			2714	
114				2715	
115				2716	
116				2717	
117				2718	
118				2719	
119	Siltstone - medium gray			2720	
120				2721	
121	Sandstone - light gray, fine grained		K-Packer	2722	
122				2723	
123				2724	
124				2725	
125				2726	
126				2727	
127				2728	
128	Siltstone - medium gray			2729	
129				2730	
130	Shale - black			2731	
131				2732	
132	Siltstone - medium gray			2733	
133				2734	
134	Coal - WEAVER, water -0.5 IGPM			2735	
135				2736	
136	Shale - black			2737	
137				2738	
138				2739	
139				2740	
140				2741	
141				2742	
142				2743	
143	Sandstone - light gray, fine grained			2744	
144				2745	
145				2746	
146	Shale - brown			2747	
147				2748	
148	Coal - WEAVER, water minor			2749	
149				2750	
	Shale - bentonitic			2751	
Alberta Research Council			LOGGED BY: Alec Blyth	COMPLETION DEPTH: 183.45 (ft)	
Shale - black			TYPE: Groundwater Monitoring Well	COMPLETED:	

Date printed: 5/1 Sep 1987

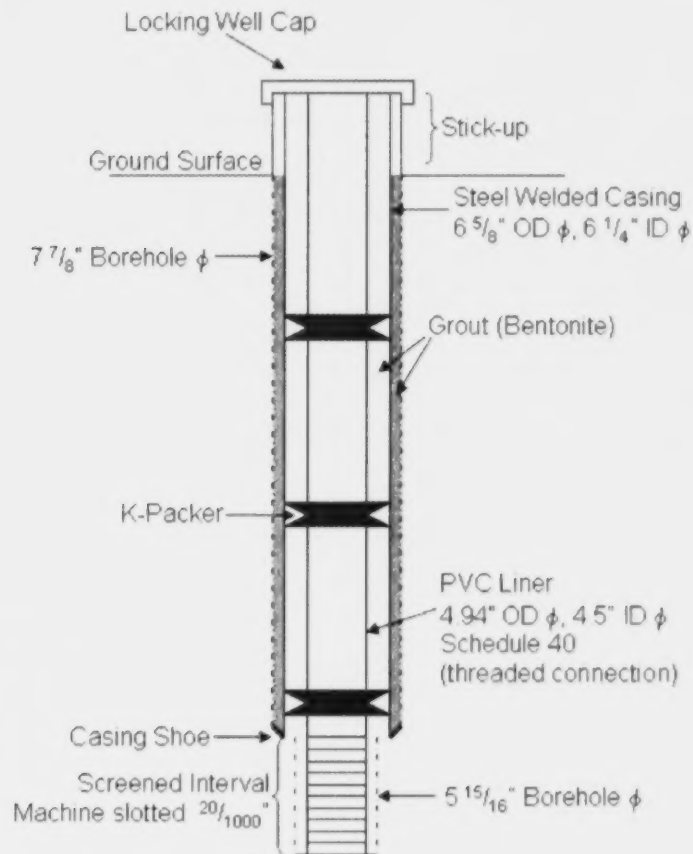
Rosebud Drilling		Rosebud/Redland		BOREHOLE: Rosebud Well 2	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.181 West: 112.569		ELEVATION: 2601.706 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input type="checkbox"/> Bentonite <input type="checkbox"/> Grout <input type="checkbox"/> Backfill <input type="checkbox"/> Sand <input type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input type="checkbox"/> Shelby Tube <input type="checkbox"/> No Recovery <input type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input type="checkbox"/> Core <input type="checkbox"/> Grab Sample					

D e p t h  (ft)	LITHOLOGIC DESCRIPTION	WELL INSTALLATION Casing diam. = 0.552 ft Borehole diam. = 0.654 ft	E l e v  (ftasl)
151	Sandstone - light gray, fine grained		2552
152			2553
153			2554
154			2555
155			2556
156			2557
157			2558
158			2559
159			2560
160			2561
161	Shale - black		2562
162			2563
163			2564
164			2565
165			2566
166			2567
167			2568
168			2569
169			2570
170			2571
171	2572		
172	Sandstone - light gray, fine grained	K-Packer	2573
173			2574
174			2575
175			2576
176			2577
177			2578
178			2579
179			2580
180			2581
181			2582
182	Shale - black		2583
183			2584
184			2585
185			2586
186			2587
187			2588
188			2589
189			2590
190			2591
191			2592
192	2593		
193	2594		
194	2595		
195	2596		
196	2597		
197	2598		
198	2599		
199	2600		
200	2601		
201	2602		
202	2603		
203	2604		
204	2605		
205	2606		
206	2607		
207	2608		
208	2609		
209	2610		
210	2611		
211	2612		
212	2613		
213	2614		
214	2615		
215	2616		
216	2617		
217	2618		
218	2619		
219	2620		
220	2621		
221	2622		
222	2623		
223	2624		
224	2625		
	2626		

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 183.45 (ft)
Date printed: 12-Apr-2007	TYPE: Groundwater Monitoring Well	COMPLETED:



Schematic Completion Diagram for Rosebud Monitoring Well #2  
(not to scale)

## Redland

9-10-27-22 W4

N 51 292437', W 113 005688, 800.6 m

Depth from Ground (feet)	Lithology Description
-----------------------------	-----------------------

0	1	<b>Silty Loam Top Soil</b> , dk. brown
1	9	<b>Clayey Silt</b> , med. brown
9	21	<b>Clayey Silt</b> , med. brown, some pebbles
21	24	<b>Gravel</b> , fine, poorly sorted, subrounded
24	35	<b>Silty Clay</b> , med. grey, occasional pebble
35	40	<b>Silty Sandy Clay</b> , med. grey, occasional pebble
40	43	<b>Silty Clay</b> , med. grey, bits of coal
43	48	<b>Clay</b> , bluish grey, hard
48	49	<b>Coal</b> , loose (not bedrock)
49	50	<b>Clay</b> , brown
50	64	<b>Clay</b> , bluish grey, hard
64	68	<b>Siltstone</b> , med. grey, highly weathered, soft
68	76	<b>Siltstone</b> , med. grey
76	80	<b>Sandstone</b> , lt grey, fine grained
80	84	<b>Shale</b> , black
84	84.5	<b>Sandstone</b> , lt brown, siliceous
84.5	90	<b>Shale</b> , black
90	96	<b>Sandstone</b> , lt grey, fine grained
96	97	<b>Shale</b> , black
97	100	<b>Sandstone</b> , lt grey, fine grained
100	107	<b>Shale</b> , black
107	108	<b>Sandstone</b> , lt grey, fine grained
108	109	<b>Shale</b> , black
109	110	<b>Sandstone</b> , lt grey, fine grained
110	116.0	<b>Shale</b> , black
116.0	118	<b>Sandstone</b> , lt grey, fine grained
118	143	<b>Shale</b> , black
143	143.5	<b>Sandstone</b> , lt grey, fine grained
143.5	145	<b>Shale</b> , black
145	145.5	<b>Sandstone</b> , lt grey, fine grained
145.5	158	<b>Shale</b> , black, hard siliceous layers at 155' and 158'
158	160	<b>Sandstone</b> , lt grey, fine grained, Water ~0.25 IGPM
160	166	<b>Shale</b> , black
166	168	<b>COAL</b> , (Weaver coal), Water ~1.25 IGPM
168	169	<b>Shale</b> , black

End of hole

Completion Details

Borehole diameter 7 7/8" from surface to 165' (50.29 m)  
 Borehole diameter 5 15/16" from 165-169' (50.92 to 51.51 m)  
 Steel Casing diameter 6 5/8" (OD), 6 1/4" (ID), welded joints, from -1.97' - 165' (-0.60m to 50.29 m)  
 Liner diameter 4 3/4" (OD), 4 5/8" (ID), threaded, from -1.97' - 169' (-0.60m to 51.51 m)  
 Screened section of liner, 20 slot machined, 160-169' (48.77 to 51.51 m)

Bentonite grout from surface to 165' (50.29 m) outside steel casing  
 Bentonite grout from surface to 160' (50.29 m) between steel casing and liner

K-Packers at 40, 80, 120 and 160'

Completed Well Measurements

Depth of well 170.69' (52.04 m) to Top of Casing  
 Casing Stick up 1.97' (0.60 m)  
 Total depth of well 168.7' (51.44 m) below ground surface  
 Static Water Level 4.76 m (below ground surface)

Rosebud Drilling		Rosebud/Redland		BOREHOLE: Redland Well	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.292 West: 113.005		ELEVATION: 2626.640 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input checked="" type="checkbox"/> Bentonite <input checked="" type="checkbox"/> Grout <input checked="" type="checkbox"/> Backfill <input type="checkbox"/> Sand <input checked="" type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input checked="" type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> No Recovery <input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input checked="" type="checkbox"/> Core <input type="checkbox"/> Grab Sample					
Depth (ft)	<b>LITHOLOGIC DESCRIPTION</b>		<b>WELL INSTALLATION</b> Casing diam. = 0.552 ft Borehole diam. = 0.654 ft		Elevation (ftasl)
1.0	Silty Loam Top Soil - dark brown				2627.0
2.0	Clayey Silt - medium brown				2628.0
3.0					2629.0
4.0					2630.0
5.0					2631.0
6.0					2632.0
7.0					2633.0
8.0					2634.0
9.0					2635.0
10.0	Clayey Silt - medium brown, some pebbles				2636.0
11.0					2637.0
12.0					2638.0
13.0					2639.0
14.0					2640.0
15.0					2641.0
16.0					2642.0
17.0					2643.0
18.0					2644.0
19.0					2645.0
20.0					2646.0
21.0					2647.0
22.0	Gravel - fine, poorly sorted, subrounded				2648.0
23.0					2649.0
24.0					2650.0
25.0	Silty Clay - medium gray, occasional pebble				2651.0
26.0					2652.0
27.0					2653.0
28.0					2654.0
29.0					2655.0
30.0					2656.0
31.0					2657.0
32.0					2658.0
33.0					2659.0
34.0					2660.0
35.0					2661.0
36.0	Silty Sandy Clay - medium gray, occasional pebble				2662.0
37.0					2663.0
38.0					2664.0
39.0					2665.0
40.0					2666.0
41.0	Silty Clay - medium gray, bits of coal		K-Packer		2667.0
42.0					2668.0
43.0					2669.0
44.0	Clay - blueish gray, hard				2670.0
45.0					2671.0
46.0					2672.0
47.0					2673.0
48.0					2674.0
49.0	Coal - loose (not bedrock)				2675.0
50.0					2676.0
51.0	Clay - brown				2677.0
52.0					2678.0
53.0	Clay - blueish gray, hard				2679.0
54.0					2680.0
55.0					2681.0
56.0					2682.0
57.0					2683.0
58.0					2684.0
59.0					2685.0
60.0					2686.0
61.0					2687.0
62.0					2688.0
63.0					2689.0
64.0					2690.0
65.0	Siltstone - medium gray, highly weathered, soft				2691.0
66.0					2692.0
67.0					2693.0
68.0					2694.0
69.0	Siltstone - medium gray				2695.0
70.0					2696.0
71.0					2697.0
72.0					2698.0
73.0					2699.0
74.0					2700.0
					2701.0
Alberta Research Council		LOGGED BY: Alec Blyth		COMPLETION DEPTH: 170.69 (ft)	
Date printed: 12-Apr-2007		TYPE: Groundwater Monitoring Well		COMPLETED:	

Rosebud Drilling		Rosebud/Redland		BOREHOLE: Redland Well		
INSTALLED BY: Alberta Research Council				SITE: 8789009		
DRILL TYPE: Air Rotary		North: 51.292 West: 113.005		ELEVATION: 2626.640 (ftasl)		
FILL TYPE: <input checked="" type="checkbox"/> Slough <input checked="" type="checkbox"/> Bentonite <input checked="" type="checkbox"/> Grout <input checked="" type="checkbox"/> Backfill <input type="checkbox"/> Sand <input checked="" type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown						
SAMPLE TYPE: <input checked="" type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> No Recovery <input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input checked="" type="checkbox"/> Core <input type="checkbox"/> Grab Sample						
Depth (ft)	LITHOLOGIC DESCRIPTION			WELL INSTALLATION		Elevation (ftasl)
				Casing diam. = 0.552 ft Borehole diam. = 0.654 ft		
76.0	Sandstone - light gray, fine grained		K-Packer			2702.0
77.0						2703.0
78.0						2704.0
79.0						2705.0
80.0						2706.0
81.0	Shale - black					2707.0
82.0						2708.0
83.0						2709.0
84.0						2710.0
85.0	Sandstone - light brown, siliceous					2711.0
86.0					2712.0	
87.0	Shale - black				2713.0	
88.0					2714.0	
89.0					2715.0	
90.0					2716.0	
91.0	Sandstone - light gray, fine grained				2717.0	
92.0					2718.0	
93.0					2719.0	
94.0					2720.0	
95.0					2721.0	
96.0					2722.0	
97.0	Shale - black				2723.0	
98.0					2724.0	
99.0	Sandstone - light gray, fine grained				2725.0	
100					2726	
101	Shale - black				2727	
102					2728	
103					2729	
104					2730	
105					2731	
106					2732	
107					2733	
108	Sandstone - light gray, fine grained				2734	
109					2735	
110	Shale - black				2736	
111					2737	
112	Sandstone - light gray, fine grained				2738	
113					2739	
114	Shale - black				2740	
115					2741	
116					2742	
117	Sandstone - light gray, fine grained				2743	
118					2744	
119	Shale - black		K-Packer			2745
120						2746
121						2747
122						2748
123						2749
124						2750
125						2751
126						2752
127						2753
128						2754
129					2755	
130					2756	
131					2757	
132					2758	
133					2759	
134					2760	
135					2761	
136					2762	
137					2763	
138					2764	
139					2765	
140					2766	
141					2767	
142					2768	
143					2769	
144	Sandstone - light gray, fine grained				2770	
145					2771	
146	Shale - black				2772	
147					2773	
148	Sandstone - light gray, fine grained				2774	
149					2775	
	Shale - black, hard siliceous layers at 155 and 158'				2776	
INSTALLED BY: Alberta Research Council		LOGGED BY: Alec Blyth		COMPLETION DEPTH: 170.69 (ft)		
		TYPE: Groundwater Monitoring Well		COMPLETED:		

Date printed: 12-Apr-2007

Rosebud Drilling		Rosebud/Redland		BOREHOLE: Redland Well	
INSTALLED BY: Alberta Research Council				SITE: 8789009	
DRILL TYPE: Air Rotary		North: 51.292      West: 113.005		ELEVATION: 2626.640 (ftasl)	
FILL TYPE: <input checked="" type="checkbox"/> Slough <input checked="" type="checkbox"/> Bentonite <input checked="" type="checkbox"/> Grout <input checked="" type="checkbox"/> Backfill <input type="checkbox"/> Sand <input checked="" type="checkbox"/> Peltonite <input type="checkbox"/> Open Hole <input type="checkbox"/> Unknown					
SAMPLE TYPE: <input checked="" type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> No Recovery <input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> Disturbed <input type="checkbox"/> Dynamic Cone <input checked="" type="checkbox"/> Core <input type="checkbox"/> Grab Sample					

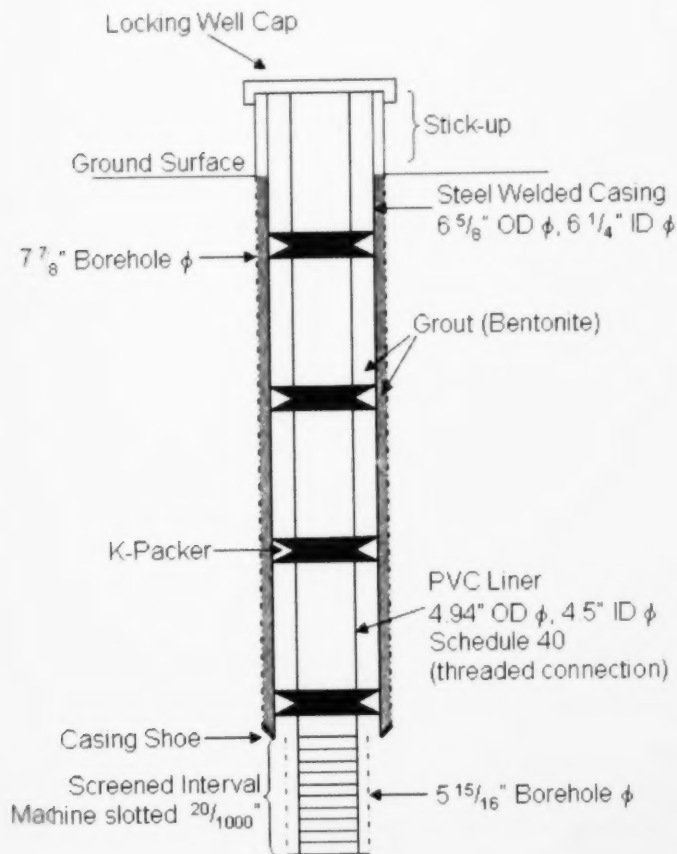
  

Depth (ft)	LITHOLOGIC DESCRIPTION		WELL INSTALLATION	Elevation (ftasl)
			Casing diam. = 0.552 ft Borehole diam. = 0.654 ft	
151				2777
152				2778
153				2779
154				2780
155				2781
156				2782
157				2783
158				2784
159	Sandstone - light gray, fine grained, water at ~0.25 IGPM			2785
160				2786
161			K-Packer	2787
162	Shale - black			2788
163				2789
164				2790
165				2791
166				2792
167	Coal - WEAVER, Water ~1.25 IGPM			2793
168				2794
169	Shale - black			2795
170				2796
171				2797
172	END OF HOLE AT 170.69 ft			2798
173	Well status: Active			2799
174				2800
175				2801
176				2802
177				2803
178				2804
179				2805
180				2806
181				2807
182				2808
183				2809
184				2810
185				2811
186				2812
187				2813
188				2814
189				2815
190				2816
191				2817
192				2818
193				2819
194				2820
195				2821
196				2822
197				2823
198				2824
199				2825
200				2826
201				2827
202				2828
203				2829
204				2830
205				2831
206				2832
207				2833
208				2834
209				2835
210				2836
211				2837
212				2838
213				2839
214				2840
215				2841
216				2842
217				2843
218				2844
219				2845
220				2846
221				2847
222				2848
223				2849
224				2850
				2851

Alberta Research Council	LOGGED BY: Alec Blyth	COMPLETION DEPTH: 170.69 (ft)
	TYPE: Groundwater Monitoring Well	COMPLETED:

Date printed: 12-Apr-2007

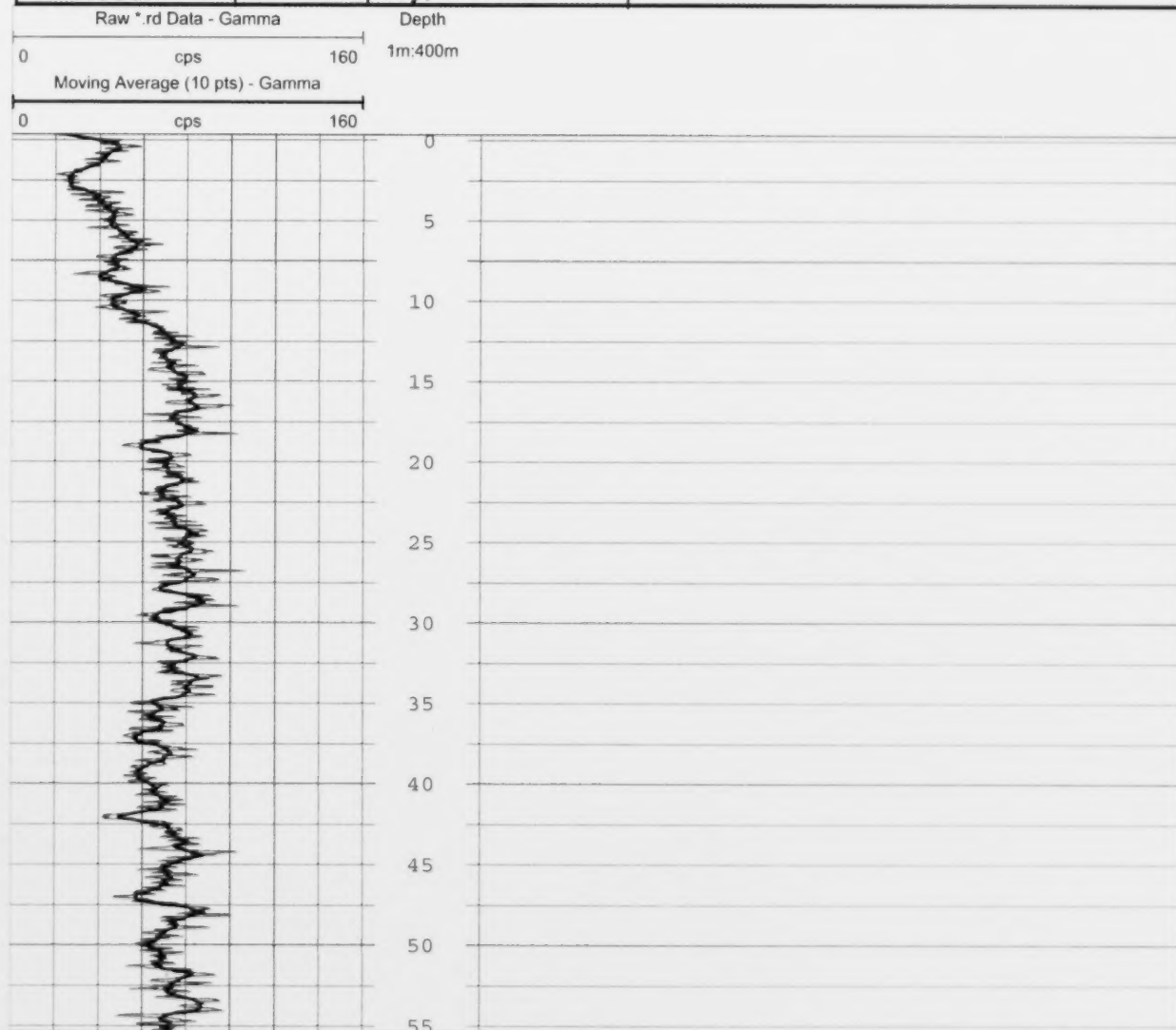


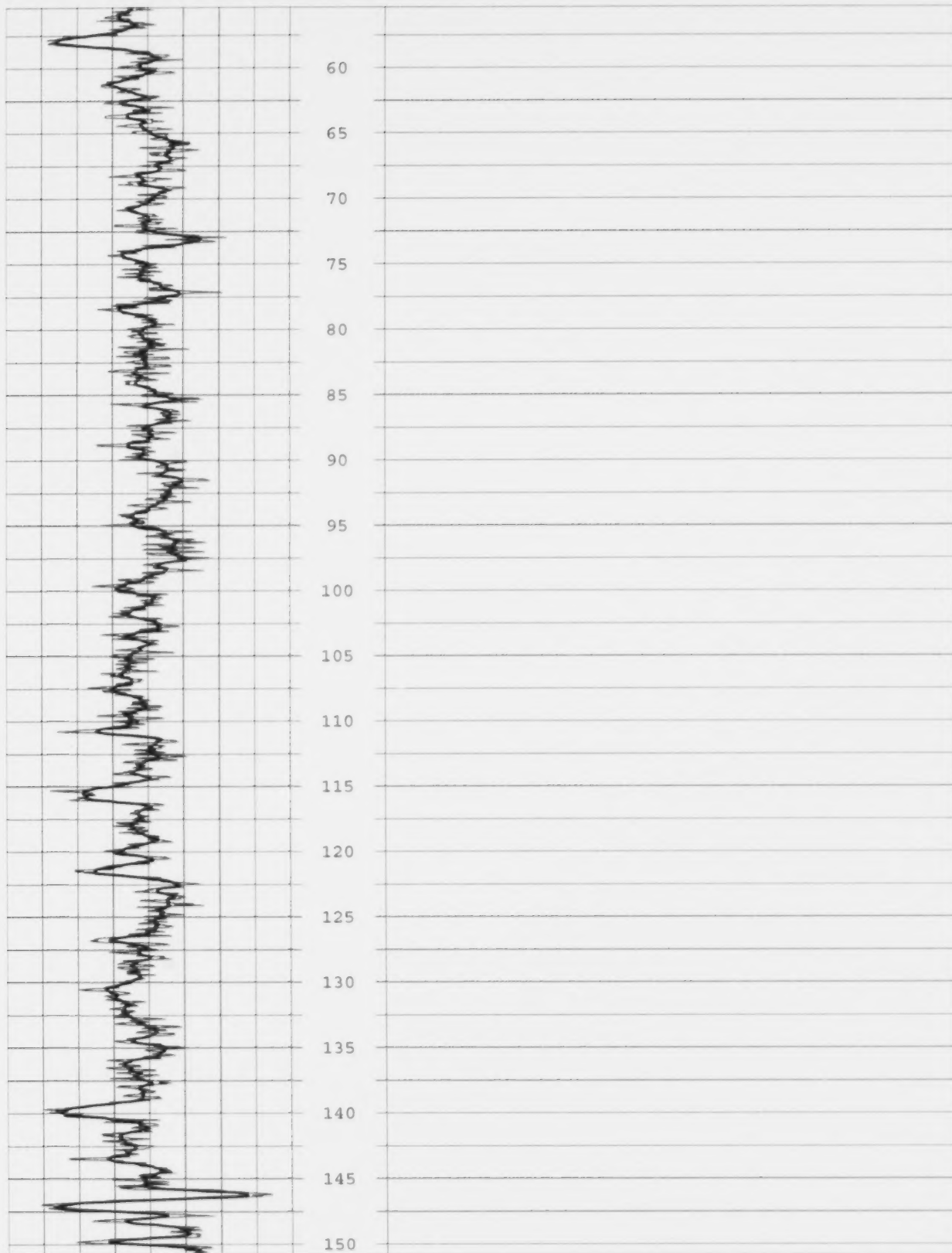
Schematic Completion Diagram for Redland Monitoring Well  
(not to scale)

Appendix B  
E-Log

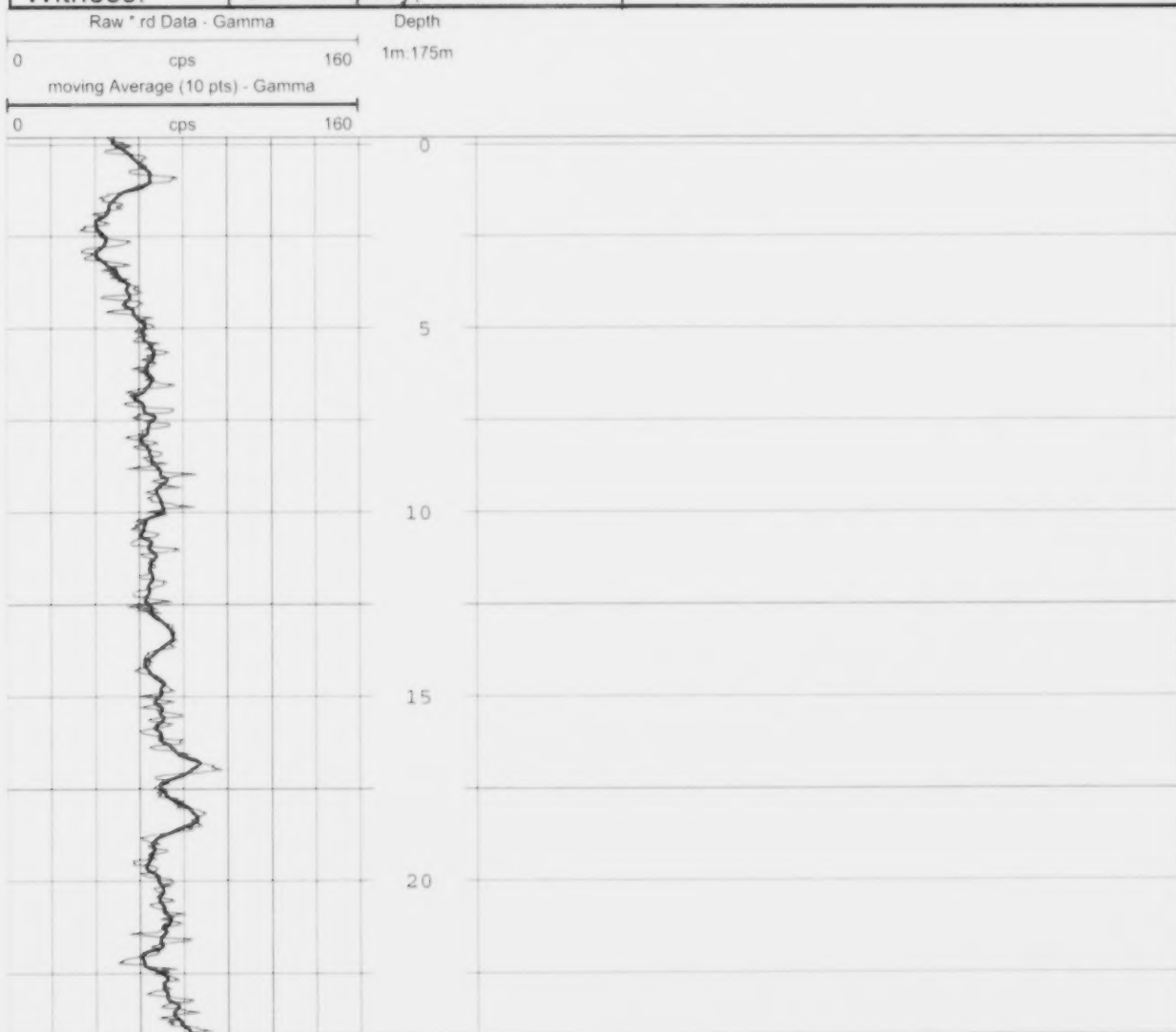


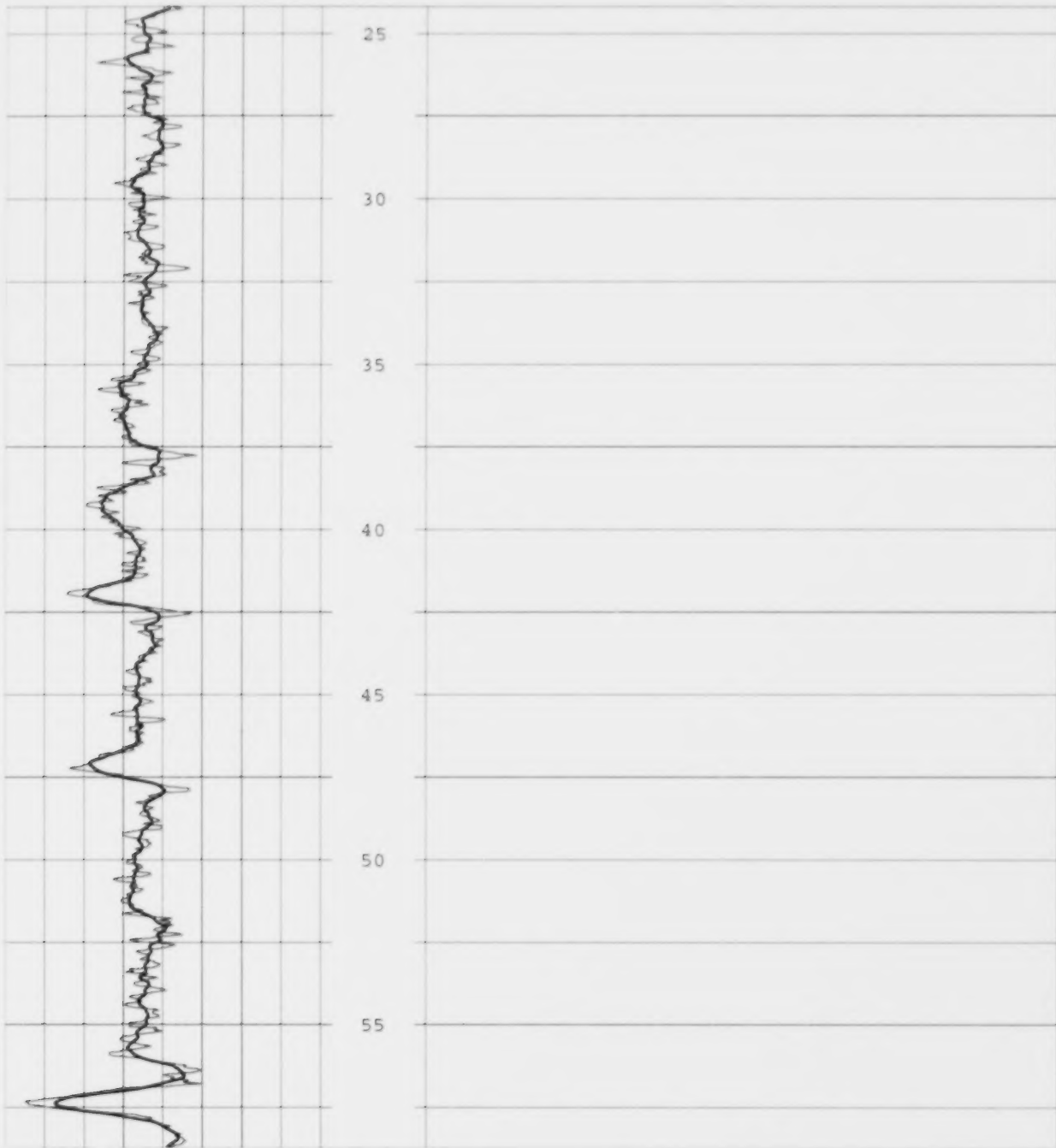
		COMPANY: ENZeeTech Inc.		
		Location: Rosebud, Alberta		
Well	Rosebud-1		<b>OTHER SERVICES</b> LSD - SW-18-27-21 W4M Elev. - 795.68 Lat. - 51.30158927 Long. - 112.94917373	
Date	March 28, 2007	BH Fluid		H2O
Casing	Steel/PVC			
File Name	Rosebud-1 up.WCL			
Depth Driller				
Depth Logger	Mount Sopris MGX II			
Logged by:	Robert Kyle			
Witness:	Cliff Dempsey, C.Tech.			





		COMPANY: ENZeeTech Inc.	
		Location: Rosebud, Alberta	
Well	Rosebud-2		OTHER SERVICES
Date	March 28, 2007	BH Fluid	H2O
Casing	Steel/PVC		LSD - SW-18-27-21 W4M Elev. - 795.68 Lat. - 51.30158927 Long. - 112.94917373
File Name	Rosebud-2 up.WCL		
Depth Driller			
Depth Logger	Mount Sopris MGX II		
Logged by:	Robert Kyle		
Witness:	Cliff dempsey, C.Tech.		





		COMPANY: ENZeeTech Inc.	
		Location: Redland, Alberta	
Well	Redland 1		OTHER SERVICES
Date	March 28, 2007	BH Fluid	H2O
Casing	Steel/PVC		LSD - 09-10-27-22 W4M Elev. - 800.6 Lat. - 51.292437 Long. - 113.005688
File Name	Redland-1 up.WCL		
Depth Driller			
Depth Logger	Mount Sopris MGX II		
Logged by:	Robert Kyle		
Witness:	Cliff Dempsey, C.Tech.		

